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[Detail of Attached Papers]

[document]	Specification	1
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[Name of the Document] SPECIFICATION

[Title of the Invention]

METHOD FOR PRODUCING V-RIBBED BELTS

[Claims]

1. A method for producing V-ribbed belts, which comprises fixing a cylindrical, unvulcanized belt sleeve having a core as embedded in its rubber layer, around a mold, then vulcanizing it and grinding the surface of the vulcanized belt sleeve to form grooves thereon, and which is characterized in that;

at least the outer peripheral surface of the unvulcanized belt sleeve being fixed around the mold is surrounded by a vapor-impervious film, then the mold is set in a vulcanizer and the belt sleeve is vulcanized therein while being airtightly sealed by the film,

and thereafter the outer peripheral surface of the belt sleeve is ground with a grinding wheel to form grooves thereon.

2. A method for vulcanizing belts as claimed in claim 1, in which the vapor-impervious film is a synthetic resin film.

3. A method for vulcanizing belts as claimed in claim 1, in which the vapor-impervious film is wound around the outer peripheral surface of the unvulcanized belt sleeve and over a part of the both ends of the mold.

4. A method for vulcanizing belts as claimed in claim 1 or 3, in which a sealing material is applied onto the

vapor-impervious film partly at the upper and lower corners of the unvulcanized belt sleeve.

[Detailed Description of the Invention]

[0001]

[Technical Field of the Invention]

The present invention relates to a method for producing power transmission belts, and more precisely, to a method for producing power transmission belts which is characterized in that belt sleeves are fully vulcanized without using any jackets and without introducing bubbles into the vulcanized belt sleeves. The method produces V-ribbed belts, toothed belts, flat belts and others with good appearance.

[0002]

[Prior Art]

In one conventional method for vulcanizing belts, an unvulcanized belt sleeve comprising a laminate of a compressible rubber layer, an expansive rubber layer and an adhesive rubber layer being sandwiched between the former two layers, and a core as embedded in the adhesive rubber layer is fitted around the outer peripheral surface of a mold; then an elastically-deformable, cylindrical jacket is concentrically fitted over the belt sleeve; the mold having the belt sleeve therearound in that condition is mounted on a supporting stand via an elastic packing material therebetween in a vulcanizer, the supporting stand being positioned in the lower part of the vulcanizer; then the top end of the mold is covered with a cover; and the

unvulcanized belt sleeve is vulcanized in the vulcanizer with applying high-pressure vapor over the jacket and low-pressure vapor into the mold (drum).

The thus-obtained, vulcanized belt sleeve is ground, using a grinding wheel having a cylindrical surface with a plurality of V-shaped ribs as integrated with the surface, to have a plurality of V-shaped ribs on its surface. For this, referred to is Japanese Patent Publication No. 7-37084.

[0003]

In the conventional method, the high-pressure vapor applied over the jacket presses the jacket against the unvulcanized belt sleeve to thereby expel air from the space between the jacket and the mold, while the unvulcanized belt sleeve is vulcanized and solidified to have a predetermined shape. It is said that the thus-vulcanized belt sleeve is stiff and has good quality without containing air bubbles.

[0004]

To prepare the jacket to be used in the conventional method, for example, an unvulcanized rubber layer having a predetermined thickness is wound around a mold and shaped into a jacket body, then a flange of unvulcanized rubber extending outward is fitted to at least one end of this body, and a different cylindrical jacket is fitted into this body, which is then vulcanized in a vulcanizer, and thereafter the thus-formed jacket is released from the mold.

[0005]

[Problems to be Solved by the Invention]

However, the conventional method for producing belt sleeves is problematic in that a plurality of rubber jackets must be prepared and stored all the time for belts of different sizes, and those rubber jackets require a large space in factories. In addition, where belts of particular sizes are produced, the frequency of using jackets for those belts is small so that the jackets used must be visually inspected every time after their use.

[0006]

Further, in ordinary assembly lines of producing belts where unvulcanized belt sleeves of different sizes are conveyed in undefined sequence, a jacket fittable to the just-conveyed belt sleeve must be picked up within a short period of time and must be fitted into the belt sleeve without delay. In fact, however, the picking out of the just-fittable jacket in various jackets of different sizes and the exchange of jackets take much time to thereby inevitably limit the production line and even cause loss of time for changing the production line.

[0007]

Moreover, in order to prevent vapor leakage through jackets that causes penetration of vapor into unvulcanized belt sleeves through jackets, special control of jackets is inevitable. For example, jackets being used for a long period of time must be carefully checked all the time as to whether or not the both flanges and the inner surface have been deteriorated, as to whether or not any dust has been

adhered to the both flanges, and as to whether or not the body length and the circumference length have changed, and good jackets with no problem in those points must be used all the time. If not, and if bad jackets are used, vapor leaks through the jackets being used, resulting in that bad belt sleeves containing air bubbles therein are produced through the vulcanization.

Furthermore, when jackets being used are exchanged for new ones, the new jackets must be fully pre-heated in the vulcanizer prior to being applied to unvulcanized belt sleeves so that the jackets are expanded to be in good size for the body length and the circumference length being fittable to the unvulcanized belt sleeves.

[0008]

The present invention is to solve those various problems inevitable in the conventional method requiring jackets, and its object is to provide a method for producing power transmission belts of good quality. The method of the invention is advantageous in that the space for the production lines is reduced, that the loss of working time is reduced, that the cost for the vulcanization of belt sleeves is reduced, and that high-quality belt sleeves containing no bubbles are prepared.

[0009]

[Means for Solving the Problems]

Specifically, the invention of claim 1 is a method for producing power transmission belts, which comprises fixing a cylindrical, unvulcanized belt sleeve having a core as

embedded in its rubber layer, around a mold, then vulcanizing it and grinding the surface of the vulcanized belt sleeve, and which is characterized in that at least the outer peripheral surface of the unvulcanized belt sleeve being fixed around the mold is surrounded by a vapor-impervious film, then the mold is set in a vulcanizer and the belt sleeve is vulcanized therein under the condition that being airtightly sealed by the film, thereafter the film is removed from the vulcanized belt sleeve, and finally the surface of the belt sleeve having been contacted with the film is ground. In this method, since the outer peripheral surface of the unvulcanized belt sleeve is surrounded by a vapor-impervious film, and since the film prevents the penetration of vapor into the belt sleeve being vulcanized, the unvulcanized belt sleeve can be vulcanized without using any jacket. Therefore, this method is suitable for small-space production lines, while reducing the loss of working time and reducing the cost for vulcanization. In addition, even when the surface of the vulcanized belt sleeve having been contacted with the film is rough, it is ground with a grinding wheel in this method. Therefore, the power transmission belts to be produced in this method always have good outward appearance.

[0010]

In the invention of claim 2, which is dependent on claim 1, the vapor-impervious film is a synthetic resin film. In this, the synthetic resin film is easily wound

around the outer peripheral surface of the unvulcanized belt sleeve to surround it.

[0011]

In the invention of claim 3, which is dependent on claim 1, or 2, the vapor-impervious film is wound around the outer peripheral surface of the unvulcanized belt sleeve and over a part of the both ends of the mold. In this, even the upper and lower corners of the unvulcanized belt sleeve are surely surrounded by the film, whereby the belt sleeve being vulcanized is more surely protected from vapor penetration thereinto.

[0012]

In the invention of claim 4, which is dependent on claim 1 or 3, a sealing material is applied onto the vapor-impervious film partly at the upper and lower corners of the unvulcanized belt sleeve. In this, the belt sleeve being vulcanized is much more surely protected from vapor penetration thereinto through its upper and lower corners.

[0013]

In the invention of claim 5, which is dependent on claim 4, the sealing material is a fibrous one selected from at least single-layered, rubber-impregnated canvas and non-woven fabric. In this, the upper and lower corners of the belt sleeve being vulcanized are more surely sealed.

[0014]

[Modes of Carrying out the Invention]

Now, the method of the invention for producing power transmission belts is described hereinunder with reference to the accompanying drawings.

Fig. 1 is a view illustrating the formation of an unvulcanized belt sleeve comprising a compressible rubber layer, a core and an expansive rubber layer, on a mold. First, a mold (drum) 1 is set in a shaping machine (not shown); one or several sheets of reinforcing fabric 2, an unvulcanized rubber sheet 3 which is to be an expansive rubber layer, and an unvulcanized rubber sheet 4 which is to be an adhesive rubber layer are wound around the drum 1; a core 5 of a cord of polyester fiber, aramide fiber, glass fiber or the like is spun thereover; and thereafter an unvulcanized rubber sheet 6, which is to be a compressible rubber layer, is wound over the core 5. In this shaping process, the compressible rubber layer is in the outermost position. Therefore, this process is generally referred to as an inverse-shaping process.

[0015]

The unvulcanized rubber sheets 3 and 6, which are to be an expansive rubber layer and a compressible rubber layer, respectively, are composed of a rubber material, such as natural rubber, butyl rubber, styrene-butadiene rubber, chloroprene rubber, ethylene-propylene rubber, alkylated chlorosulfonated polyethylene, hydrogenated nitrile rubber, and a mixed polymer of hydrogenated nitrile rubber and a metal salt of an unsaturated carboxylic acid, or a mixture of those rubber materials, and short fibers of,

for example, para-aramide fiber (trade name: TWARON, KEVLAR, TECHNORA), nylon, polyester, vinylon or cotton, in which the short fibers are oriented in the direction of the width of the belt. The amount of the short fibers to be added may be from 5 to 40 parts by weight relative to 100 parts by weight of rubber.

The adhesive rubber layer may contain those short fibers, but preferably does not contain them.

[0016]

The reinforcing fabric 2 is made of cotton, polyester fiber, nylon or the like, and is woven in plain weave, twill weave, satin weave or the like. This may be wide-angle canvas in which the weft and the warp intersect at a wide angle of from 90 to 120 degrees or so. The reinforcing fabric 2 is, after having been processed with RFL, coated with a rubber composition through friction coating to be rubber-impregnated canvas. RFL is a mixture of resorcinol-formalin precondensate with latex, in which the latex may be any of chloroprene, styrene-butadiene-vinylpyridine terpolymer, hydrogenated nitrile, NBR, etc.

[0017]

Fig. 2 is a view illustrating the application of a vapor-impervious film 8 onto the outer peripheral surface 9 of the unvulcanized belt sleeve 7 formed around the mold 1, in which the belt sleeve 7 is being surrounded by the film 8. As in this, the vapor-impervious film 8 is spirally wound around the outer peripheral surface 9 of the unvulcanized belt sleeve 7 fitted over the mold 1, which

was taken out of the shaping machine, and partly over the both ends 10 of the mold 1. In this step, the film 8 being spirally wound around the unvulcanized belt sleeve 7 must overlap with the underlying one at their ends in order that the belt sleeve 7 is not exposed. Needless-to-say, a plurality of films 8 may be wound around the belt sleeve 7. Preferably, from 2 to 4 films 8 are wound around it.

The film 8 may be a wide one. Such a wide film 8 is not spirally wound around the belt sleeve 7 but may be singly wound around it.

[0018]

The unvulcanized belt sleeve 7 thus surrounded by the film 8 is, as in Fig. 3, such that the film 8 covers not only the outer peripheral surface 9 of the belt sleeve 7 but also a part of the both ends 10 of the mold 1 to thereby surround the corners 12 of the mold 1. In that condition, the film 8 protects the belt sleeve 7 from penetration of vapor thereinto during vulcanization.

[0019]

The vapor-impervious film 8 to be used herein is preferably a synthetic resin film of, for example, polyamides, aramides or polyesters, such as polymethylpentene, polyvinylidene chloride, polyvinyl chloride, polyethylene, polypropylene, nylon 6, nylon 6,6, nylon 6,10 or the like. Of those, synthetic resin films of polyvinylidene chloride (e.g., Saran Wrap®) are preferred, since they can easily surround the unvulcanized belt sleeve 7 without being peeled off therefrom during vulcanization

as thermally shrink little, and since they can be used safely without generating any toxic gas during vulcanization.

The thickness of the film 8 is not specifically defined, but the film 8 is preferably thin as being easily wound around the belt sleeve 7.

[0020]

The mold 1 having the unvulcanized belt sleeve 7 fitted thereto while being surrounded by the film 8 is, as in Fig. 5, set in a vulcanizing device 15. In this vulcanizing device 15, the mold 1 having the unvulcanized belt sleeve 7 fitted thereto while being surrounded by the film 8 is mounted on a supporting stand 17 positioned in the lower part of the vulcanizer 16, and a cover 18 is put over the top end of the mold 1. In that condition, high-pressure vapor is introduced into the space outside the mold 1, while low-pressure vapor is into the inside of the mold 1, whereby the unvulcanized belt sleeve 1 is vulcanized. Those high-pressure vapor and low-pressure vapor are introduced through the inlet 19, and water formed inside the vulcanizer 16 is drained away through the drain 20.

[0021]

The vulcanization condition is not specifically defined, but the vulcanization temperature is preferably controlled to be such that the film 8 does not melt at the controlled vulcanization temperature. Concretely, the

vulcanization temperature preferably falls between 140 and 160° C.

[0022]

Fig. 4 is a view illustrating the provision of a sealing material 22 partly over the film 8 at the upper and lower corners 12 of the mold 1, in which the upper and lower corners of the mold 1 are thus more airtightly sealed. Using the sealing material 22 as in Fig. 4, the upper and lower corners of the mold 1 are surely airtightly sealed. The sealing material 22 is rubber-impregnated canvas of spun yarns of, for example, polyamide fiber (e.g., nylon 6, nylon 6,6, nylon 6.10, nylon 4,6, nylon 12) or polyester fiber, or filament yarns of polyvinyl alcohol, polyethylene, polypropylene or the like, or cotton. This is preferably a single-layered sheet or in the form of 2-ply to 4-ply laminate.

[0023]

After the vulcanization, the mold 1 is taken out of the vulcanizer 16, and the film 8 can be easily peeled off from the surface of the vulcanized belt sleeve 7. The used film 8 is scrapped. The belt sleeve 7 is released from the mold 1. The surface of the belt sleeve 7 is rough, as compared with that of a comparative belt sleeve as differently vulcanized using a jacket, since the belt sleeve 7 is directly vulcanized. However, the belt sleeve 7 is fully vulcanized herein without having any pores therein.

[0024]

The belt sleeve 7 is ground with a grinding wheel 25, as in Fig. 6. Briefly, the belt sleeve 7 is run under predetermined tension while being hung between the driving roll 26 and the driven roll 27 in such a manner that the compressible rubber layer of the belt sleeve 7 faces outward. The running speed of the belt sleeve 7 is not specifically defined.

While being rotated, the grinding wheel 25 is positioned adjacent to the driving roll 26 or to the driven roll 27, and is moved to be in contact with the running belt sleeve 7 to grind the surface of the belt sleeve 7 thereby forming a plurality of 3 to 100 grooves all at once in the surface of the belt sleeve 7.

The rotating direction of the grinding wheel 25 may be the same as or opposite to the running direction of the belt sleeve. In the illustrated embodiment, the grinding wheel 25 is rotated oppositely to the running belt sleeve 7. The number of rotation of the grinding wheel 25 may fall between 400 and 2,000 rpm.

[0025]

A part of the ground powder as expelled from the grinding wheel 25 adheres to the belt sleeve 7, while the other is led into a suction duct (not shown) that surrounds the grinding wheel 25, and discharged outside the grinding device.

The ground powder as adhered to the belt sleeve 7 is removed by means of the rotary brush 28, and is directly

discharged outside the grinding device by means of the vacuum discharger 29.

[0026]

The rotary brush 28 is positioned adjacent to the driving roll 26, and is mounted on the supporting stand 31 connected to the cylinder 30. In addition, the rotary brush 28 is connected to the driving motor 33 via the power transmission belt 32, and is rotated oppositely to the running belt sleeve 7. The number of rotation of the rotary brush may be between 100 and 800 rpm, and the pressure under which the rotary brush 28 is contacted with the belt sleeve 7 may be between 2 and 6 kg/cm (linear pressure).

Since the rotary brush 28 must be contacted all the time with the surface of the belt sleeve 7 under a predetermined pressure, it must be moved suitably all the time while the belt sleeve 7 is ground.

[0027]

The rotary brush 28 has filaments of synthetic fiber, such as nylon or polyester, or metal wires of brass or the like as planted on the surface of its rotary shaft.

[0028]

The grinding wheel 25 to be used herein is not specifically defined, but, for example, it may be illustrated as in Fig. 7, in which grinding hills 35 are formed alternately at predetermined pitches in the circumferential direction (as shown by the arrow in the drawing) of the wheel 25, and in which the grinding hills

35 each have ribs 36, of which the cross section is triangular, and grooves 37 as alternately formed on their surfaces at predetermined pitches in the widthwise direction of the surface of the wheel 25 but in the oblique direction relative to the rotary axis of the wheel 25. The surface of the rib 36 and the groove 37 has grains 38 of diamond or the like of from 100 to 120 meshes in size, as adhered thereto, while the tip 40 including the edge 39 of the rib 36 of the grinding hill 35, which is contacted with the belt sleeve 7 being ground therewith, also has the same grains 38 as adhered thereto.

[0029]

At the grooved slit 41 formed between the adjacent grinding hills 35, the stress of the surface of the belt sleeve 7 being ground is removed to thereby restore the deformed belt sleeve 7 to its original condition. Due to the presence of those grooved slits 41, the surface of the belt sleeve 7 is safely and accurately ground by the adjacent grinding hills 35 between which the grooved slit 41 exists, without having any negative stress. For these reasons, the number of the slits 41 is preferably larger.

[0030]

The belt sleeve 7 is cut to give a V-ribbed belt 11 having a predetermined width, as in Fig. 8. As illustrated, the V-ribbed belt 11 has a plurality of grooves 43 as formed through grinding, and short fibers are exposed out of its surface to be in contact with pulleys.

[0031]

[Examples]

Examples of the invention are described below.

Example 1:

Polyethylene terephthalate fiber of 1,100 deniers in size was twisted at a count of final twist of 11.4 per 10 cm and at a count of primary twist of 21.0 per 10 cm in opposite directions to give a core cord as twisted at a twist multiplier of 2 x 3. This cord had 6,600 deniers in total size. The raw cord was pre-dipped in an isocyanate-type adhesive, then dried at about 170 to 180°C, thereafter dipped in RFL, and finally fixed under heat at 200 to 240°C with stretching it to obtain a processed cord.

[0032]

Plain weave canvas of cotton spun yarns was used as reinforcing fabric. This was dipped in RFL, and then heated at 150°C for 2 minutes to obtain processed canvas. Next, the processed canvas was coated with a rubber composition through friction coating to obtain rubber-impregnated canvas.

[0033]

A rubber composition comprising chloroprene rubber and containing short aramide fibers was used to form a compressible rubber layer and an expansive rubber layer. A rubber composition comprising chloroprene rubber but not containing short fibers was used to form an adhesive rubber layer.

[0034]

After those materials were prepared, the reinforcing fabric, the unvulcanized rubber sheet to be an expansive rubber layer, the unvulcanized rubber sheet to be an adhesive rubber layer, the core cord, and the unvulcanized rubber sheet to be a compressible rubber layer were wound in that order around a mold having a smooth surface to give an unvulcanized belt sleeve. Next, a synthetic resin film (Saran Wrap®) was spirally wound in a 2-ply state around the outer surface of the unvulcanized belt sleeve and partly over the both ends of the mold, and the rubber-impregnated canvas was applied onto the synthetic resin film at the upper and lower corners of the mold. The mold was set in a vulcanizer, in which the unvulcanized belt sleeve was vulcanized.

[0035]

The mold was taken out of the vulcanizer, and it was easy to peel off the synthetic resin film from the outer surface of the vulcanized belt sleeve. Inspecting the outward appearance of the vulcanized belt sleeve, it was found that the surface of the belt sleeve was somewhat rough since the belt sleeve was directly vulcanized, but was not porous at all.

[0036]

As in Fig. 6, the thus-obtained belt sleeve was run under predetermined tension while being hung between a driving roll and a driven roll. In this condition, a diamond-fixed grinding wheel was rotated at 1,800 rpm

oppositely to the running belt sleeve to thereby grind the belt sleeve, and a rotary brush of brass was run at 450 rpm oppositely to the running belt sleeve while being pressed against the belt sleeve at a pressure of 2.0 kg/cm^2. Using a vacuum device, the vacuum degree was controlled to be 25 m/sec.

As a result of this grinding operation, 80 grooves were formed all at once on the surface of the belt sleeve. The depth of each groove was about 2 mm. The grinding time was 3.5 minutes.

[0037]

The thus-ground belt sleeve were cut to give V-ribbed belts each having a width of 3 ribs. The surface of the thus-obtained, V-ribbed belts had no pores, and all those belts were fully vulcanized. The belts all had good outward appearance with short fibers being exposed out of their surface.

[0038]

[Advantages of the Invention]

As has been described hereinabove, the invention of claim 1 is a method for producing power transmission belts, which is characterized in that at least the outer peripheral surface of an unvulcanized belt sleeve being fixed around a mold is surrounded by a vapor-impervious film, then the mold is set in a vulcanizer and the belt sleeve is vulcanized therein under the condition that being airtightly sealed by the film, thereafter the film is removed from the vulcanized belt sleeve, and finally the

surface of the belt sleeve having been contacted with the film is ground. In this method, since the outer peripheral surface of the unvulcanized belt sleeve is surrounded by a vapor-impervious film, and since the film prevents the penetration of vapor into the belt sleeve being vulcanized, the unvulcanized belt sleeve can be vulcanized without using any jacket. Therefore, this method effectively solves various problems that occur in conventional vulcanization methods using jackets.

[0039]

In the invention of claim 2, the vapor-impervious film is a synthetic resin film. In this, the synthetic resin film is easily wound around the outer peripheral surface of the unvulcanized belt sleeve to surround it.

[0040]

In the invention of claim 3, the vapor-impervious film is wound around the outer peripheral surface of the unvulcanized belt sleeve and over a part of the both ends of the mold. In this, even the upper and lower corners of the unvulcanized belt sleeve are surely surrounded by the film, whereby the belt sleeve being vulcanized is more surely protected from vapor penetration thereinto.

[0041]

In the invention of claim 4, a sealing material is applied onto the vapor-impervious film partly at the upper and lower corners of the unvulcanized belt sleeve. In this, the belt sleeve being vulcanized is much more surely

protected from vapor penetration thereinto through its upper and lower corners.

[0042]

In the invention of claim 5, the sealing material is a fibrous one selected from at least single-layered, rubber-impregnated canvas and non-woven fabric. In this, the upper and lower corners of the belt sleeve being vulcanized are more surely sealed.

[Brief Description of the Invention]

[Fig. 1]

This is a view illustrating a step of forming an unvulcanized belt sleeve on a mold in the method of the invention for producing power transmission belts.

[Fig. 2]

This is a view illustrating the application of a film onto the unvulcanized belt sleeve formed around the mold in the method of the invention, in which the belt sleeve is being surrounded by the film.

[Fig. 3]

This is a view illustrating the application of the film not only to the outer surface of the unvulcanized belt sleeve but also partly over the both ends of the mold in the method of the invention.

[Fig. 4]

This is a view illustrating the provision of a sealing material partly over the wrapping film at the upper and lower corners of the mold in the method of the invention.

[Fig. 5]

This is a view illustrating the unvulcanized belt sleeve as fitted around the mold, in which the unvulcanized belt sleeve is being vulcanized according to the method of the invention.

[Fig. 6]

This is a front view illustrating a belt sleeve being ground according to the method of the invention.

[Fig. 7]

This is a partly-cut, perspective view of a grinding wheel to be used in the method of the invention.

[Fig. 8]

This is a partly-cut, cross-sectional view of a V-ribbed belt obtained in the method of the invention.

[Description of Reference Numerals]

1 Mold

2 Reinforcing fabric

3 Unvulcanized rubber sheet

4 Unvulcanized rubber sheet

5 Core

6 Unvulcanized rubber sheet

7 Belt sleeve

8 Film

11 V-ribbed belt

15 Vulcanizing device

16 Vulcanizer

22 Sealing material

25 Grinding wheel

CERTIFICATION

I, Koji Yano

of No.1-85-401,1-chome,Kaminotani,Suma-ku,Kobe-shi,Hyogo,Japan

hereby certify that I am the translator of the certified official copy of the documents in respect of an application for a patent application filed in Japan on January 16, 1997 , application No. 019844/1997 , and of the official certificate attached thereto, and certify that the following is a true and correct translation to the best of my knowledge and belief.

Koji Yano

(Koji Yano)

Date this 25th day of February, 1998